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REPORT OF THE SIXTH NORTH PACIFIC ALBACORE WORKSHOP

by

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and

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ADMINISTRATIVE REPORT LJ-82-02

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I. INTRODUCTION

In keeping with the informal agreement on a joint research program for North Pacific Albacore resources, reached in 1974, between the Southwest Fisheries Center (SWFC; United States) and the Far Seas Fisheries Research Laboratory (FSFRL; Japan), the Sixth North Pacific Albacore Workshop was held from September 1 to 4, 1981, at the FSFRL, Shimizu. Scientists from the U. S. and Japan and Canada participated. It appears that recent utilization of the North Pacific albacore stock has been at a high level, and consequently, more intensive and continued research effort should be encouraged to obtain a better understanding of the biology and dynamics of the resource.

The participants (Appendix A) were welcomed by Dr. K. Tatara, Director of the FSFRL, who stressed the importance of the North Pacific albacore resource for fishermen of both countries, and also expected full discussion of the dynamics of various component fisheries and reaction of the resource to these fisheries and the environment. He expressed the hope that fruitful conclusions would emerge from the research results presented at this Workshop. Mr. S. Kume, serving as Chairman, appointed Dr. N. Bartoo to assume the roles of co-chairmanship and general rapporteur. Rapporteur groups by major topics of the Working Agenda (Appendix B), adopted by the participants were formed. In Appendix C are listed 18 working papers* presented to the Workshop.

*Working papers used at the Sixth North Pacific Albacore workshop were intended to encourage discussions at the meeting, and may be obtained by contacting individual authors directly. References to the working papers are given in the text as NPALB/81/1-18.

II. CURRENT RESEARCH

A. Biology and Ecology

Age Determination

1. Daily Ring Counts

Results of further studies to test the assumption that increments of growth are deposited daily on the otoliths of albacore are reported in NPALB/81/6. Latest information confirms earlier indications that in tetracycline injected tagged specimens the relationship between otolith ring increments and days at liberty is close to 1:1. This opens the way to determining with considerable accuracy the length of albacore at the first birthday. Furthermore comparison of ages determined by otolith ring counts, may help to resolve uncertainties in the aging of albacore from finray cross-sections.

2. The Use of Finrays for Age Estimation

The method of age determination involving examination of patterns of rings shown in cross-sections of dorsal finrays continues to show promise as a relatively quick way of determining age (NPALB/81/7). Specimens collected from the North American jig fisheries in the summer of 1979 and 1980, suggest that fish within 62-67cm and 75-80cm length ranges had completed 3 and 4 years of growth, respectively.

From examination of a limited number of small fish (36-46cm) taken in the U. S. coastal fishery south of 32°N there are indications that the first growth check is deposited in the December-February period. Whether this is common to all albacore in their first year of life in the North Pacific cannot be determined without periodic sampling throughout the late fall to early spring period in other areas.

Attempts to back-calculate length at age from finrays of large albacore caught in the long-line fishery produce results that suggest the first birthday length averages about 50cm. This figure is considered to be about 15cm too high, but as yet no satisfactory explanation can be given for this difference, other than the possibility that it is a reflection of an inverted or reverse "Lee's phenomenon". Alternatively, there is the possibility that the first annulus is not visible on finrays of large/old albacore. Yet even when back-calculation is attempted from specimens of young (age 2 to 5) albacore, the first annulus is calculated to occur at a length of about 50cm. Further study is obviously necessary, particularly of the question whether the relatively soft tissues of finrays is appropriate for back-calculation analysis.

Albacore Physiology

For the first time, albacore have been placed in a specially designed shipboard respirometer. Laurs, in an oral report, stated that information is now being obtained on oxygen uptake and swimming speed through use of this equipment.

B. Stock Structure

In recent years an increasing amount of evidence indicates that the North Pacific albacore population is complex and probably consists of more than a single stock. Results from tagging studies, investigation of growth rates, and examination of size composition of fish caught in the North American surface fishery suggests (1) that there are at least two substocks of fish that comprise the North Pacific albacore population, and (2) that these substocks have different migration patterns.

To re-evaluate the single stock hypothesis suggested by Suda in the late 1950's and early 1960's, Shiohama (NPALB/81/12) reviewed the size composition of the Japanese longline-caught albacore for the years 1965 to 1978. He concluded that as far as consideration of the longline data is concerned, there is no special reason to separate the North Pacific population into substocks. He also referred to the distribution of albacore larvae from research vessel surveys and recent hook rate distribution to confirm his idea that there is probably a single ocean-wide stock in the North Pacific albacore.

Asano (NPALB/81/8) presented results from tag release-recapture data of albacore from the recent years 1975-1981. Additional evidence of tagged albacore movement between the areas occupied by the U. S. fishery and Japanese summer and fall fishery was obtained.

Lauri reviewed the evidence that indicates a multi-stock structure composition in the North Pacific albacore population. Tag release-recapture information. The release locations of albacore tagged off North America were assigned to three areas: Inshore of about 130°W and north of 40°N (Area 1); Inshore of 130°W and south of 40°N (Area 2); and offshore 130°W to about 170°W (Area 3). The tagged fish released in the three areas showed different migration patterns. The majority (more than 45 percent) of the tagged fish recovered from Area 1 have been recaptured by the Japanese pole-and-line fishery, and about 3 percent from the Japanese longline fishery west of 180° . About 30 percent were recovered by the U. S. fishery in Area 1. Of special interest is that only one fish tagged in Area 1 has been recovered in Area 2 during the same season of release and only 7 percent after being at liberty for more than one year. For Area 2, nearly 80 percent of the recoveries have been made in Area 2 (45 percent after being at liberty more than one season). Less than 5 percent have been recovered by the Japanese pole-and-line fishery and 3 percent by the Japanese and Korean longline fisheries east of 180° (there have been no recoveries from the longline fisheries operating west of 180°). Also of special interest is the fact that only 2 fish tagged in Area 2 have been recovered in Area 1 during the season of release and less than 6 percent after being at liberty more than one year. For Area 3 nearly 30 percent of the recaptures have been in Area 1, slightly more than 30 percent in Area 2, about 25 percent in the Japanese pole-and-line fishery and almost 0.5 percent and 2 percent in the longline fisheries east and west of 180° , respectively. In Area 3 fish released north of about 35°N were recovered in Area 1 and those released south of this latitude were recovered in Area 2. Therefore it is quite likely that the tagged fish recovered by the Japanese pole-and-line fishery and the longline fishery west of 180° passed through Area 1 before being recaptured.

Laurs also described the results of albacore growth rate studies based on tag returns and published by Wetherall and himself which show that the proposed "northern" substock of fish has a significantly slower growth rate than fish from the proposed "southern" substock. This is supported by evidence that there are modal differences in the size composition of albacore caught north and south of about 40°N latitude in the North Americas surface fishery (NPALB/81/1 and NPALB/81/4).

Thus results from migration studies, investigation of growth rates, and examination of size composition of albacore landed in the U. S. fishery suggest that there are at least two substocks of fish that contribute to the North American fishery. In addition it appears that these substocks have different migratory patterns. The proposed northern substock of fish appears to make trans-Pacific migrations between the eastern and western North Pacific resulting in an exchange of fish between the northern area (north of about 40°N) of the U. S. fishery and the Japanese livebait fishery, and the longline fishery west of 180° . The proposed southern substock of fish has a different migration scheme from the northern one, and appears to enter the U. S. fishery south of about 40°N and the longline fishery east of 180° . Only a very small proportion of the southern group of fish appear to migrate between the eastern and western Pacific and enter the Japanese pole-and-line fishery. Also during a given season there is very little exchange of fish in the U. S. fishery between the proposed northern and southern substocks.

To further investigate the population structure of the North Pacific albacore an electrophoretic investigation of protein variability was conducted by Graves and Laurs (NPALB/81/5). Forty-six loci were surveyed. Four of these demonstrated allelic variation with three being weakly polymorphic and one being highly polymorphic. These four loci can be used as genetic markers for further studies of population differentiation in the albacore because the polymorphisms appear to be stable. As all four loci are present in eye tissue, sampling of additional fish should be relatively simplified. On the basis of these results it is planned to sample fish from different areas in order to determine if allele frequency differences exist at the variable loci which might indicate restricted gene flow between groups and subpopulations. After discussing the interpretation of results, the participants felt that the population structure of the North Pacific albacore needs further examination.

C. Oceanographical Aspects

Moritat and Yamanaka presented a report (NPALB/81/10) on the surface temperature pattern obtained by infrared (IR) image of the geostational Satellite (GMS-1) in relation to pole-and-line fishing grounds in the North Pacific. An example was given of the color display of sea surface temperature (with "sea-truth" calibration and a manually drawn SST map of the IR image area (May 24, 1980). Location of the pole-and-line fishing ground on the same day and that of a large mesh gill net operation were plotted on the map, to show the relationship between the fishing ground formation and location of the Kuroshio Front. By comparing the location of the front shown in two successive pictures taken in a 12-hour interval it was shown that the front appears to shift rather fast even within short period, and thus possibly causes rapid movement of the fish schools.

In subsequent discussion the working group felt that application of remote sensed data in fisheries oceanography in offshore waters would be very helpful in understanding migrations and stock structure of highly migratory fish like albacore.

Laurs presented a report on the study of vertical distribution and migration of albacore in relation to thermal structure of the sea using acoustic telemetry (Figures, Appendix D). The tagged fish were traced by a hydrophone for 30-hour periods. In daytime the swimming depth fluctuated vigorously with a tendency to occupy deeper depths, while the night time showed less variance of swimming depth and upward movement to shallower depths. In either case the fish stayed within and below the thermocline but not in the surface mixed layer. These results suggest a modification of the traditional concept of the vertical distribution and migration of the albacore.

After some discussion the workshop felt that this method is a powerful tool to study the behavior and vertical distribution, particularly as a means of understanding and interpreting changes in availability of albacore to the fishery.

D. Simulation Modeling of North Pacific Albacore

The participants discussed progress made on the North Pacific albacore simulation model (NPALB/81/3). The simulation model project is being undertaken by scientists from the Southwest Fisheries Center with the help and guidance of many of the workshop participants.

The Southwest Fisheries Center (SWFC) initiated in late 1980 an effort to improve its understanding of the North Pacific albacore population by integrating population dynamics, migration dynamics, known and hypothesized life history parameters, fishery information, economic information, and oceanographic parameters and processes into a formalized model (framework). This model will allow the testing of hypotheses concerning the albacore population and its interaction with both the ocean environment and the harvesting fisheries.

The explicit purpose of the project is to improve assessment of albacore stocks by 1) making a mathematical statement of current hypotheses on albacore stock dynamics (growth, mortality, recruitment and migration as related to the environment) for comparison with observed data (fishery, tagging, etc.) as a test of the consistency of these hypotheses and 2) developing alternative hypotheses to explain inconsistencies revealed by 1. Success in reaching these objectives will lead to improved management advice.

The North Pacific albacore modeling project is being developed in three general phases; 1) formulation of the model software and assembly of the support hardware, 2) compilation and formulation of the environmental data base to be used to quantify ocean processes affecting albacore as input to the model, and 3) estimation from fishery data of the needed model parameters (i.e. natural mortality, migration rates, etc.) for the initial hypothesis testing.

Formulation of model software and assembling of related hardware is approximately 60 percent complete. The simulation has been programmed to run on computers available at the Southwest Fisheries Center. Initial estimates of many of the input variables have been made. Compilation of oceanographic and environmental data to investigate ocean processes associated with the albacore is about half done, while quantification of ocean processes is just beginning and input is being sought from experts.

The participants looked forward to evaluating the initial model outputs at the next workshop.

E. Stock Length and Age Structures

Several working papers were discussed which dealt with analysis of stock dynamics.

The trend towards larger and presumably older fish at lower latitudes was shown in NPALB/81/9. Using a weight-based analysis, the conclusion was reached that the sizes of albacore in the catches are generally larger as latitude decreases. This has been seen in the statistics from other fisheries also. A generalized migration pattern was also hypothesized, however, the participants noted that the pattern did not take into account available information from tagging and other fisheries.

A means of reducing or eliminating bias where estimating age structures from sampled length frequencies was discussed (NPALB/81/2). The procedure uses a conventional Von Bertalanffy growth equation but employs additional information on the probability of fish of a given length being assigned to a particular age. An example demonstrated the adequacy of the method. It was noted that this procedure could be used to age catches which contained strong and weak year classes.

III. REVIEW OF CURRENT FISHERIES

A. Japanese Fishery

Recent Japanese pole-and-line and longline fisheries are referred to in NPALB/81/11 and the large meshed drift gill-net fishery in NPALB/80/14 and NPALB/81/17.

Pole-and-Line-Fishery

The large scale cold water mass disappeared in February 1981 and the Kuroshio resumed its flow along the coast of central Honshu. Reflecting this change relatively good fishing success was seen in the cooler zone just outside the Kuroshio from April to mid-June. Four year old fish predominated the albacore landings from this area. Fishing success was generally poor in the overall "Front" Area. Landings from the 1981 summer fishery are estimated to be as low as about 20,000 MT.

Longline Fishery

A good albacore fishing ground with hook rates of 4-6 percent was formed north of Hawaiian Islands from November 1980 to January 1981. In the North Pacific Ocean west of the date line, winter longline fishing proceeded as usual from September 1980 to March 1981, resulting in relatively poor hook rates of all species combined at 0.4-1.5 MT/day.

Drift Gillnet Fishery (OME-AMI)

This fishery is currently developing on albacore in the North Pacific. In 1981, good fishing success was reported to occur in June and July in the central Pacific, 35-42°N and 176-155°W. In mid-August, fishing grounds were located in 43-45°N and 180-152°W, and catch rate was 200-1000 fish/day. Because most of OME-AMI boats are seasonal or part-timers and it is rather difficult to collect reliable effort data. Nominal fishing days estimated from available log book records differ considerably from year to year. Rough estimation gives 13,000 boat-days in 1977, 14,000 in 1978 and 7,000 in 1979, for the entire OME-AMI fleet, including coastal participants.

B. U. S. Fishery

The 1980 U. S. albacore fishery was reported in NPALB/81/4. Relatively poor fishing success marked the U. S. albacore fishery for the second consecutive year in 1980. Landings are estimated to total a little over 8,160 MT. This is only slightly higher than the total landings made in 1979, and considerably below the seasonal 10-year average of about 20,900 MT.

There appear to be a number of factors contributing to the low landings of albacore in 1980 including: 1) the late arrival of the northern substock of fish into waters off Oregon, Washington and Canada, 2) the failure of the fishery to develop fully off southern and central California despite an initial early appearance of fish, 3) the low availability of 5.5 to 6.8 kg fish off California south of Cape Mendocino (this size of fish normally makes up a significant portion of U. S. catch), 4) fish not biting, in particular in the Cortes Bank and San Juan Seamount areas and off Central California, and 5) high winds and rough seas hampering fishing effort, notably off California.

Albacore landings made by the U. S. fishery through mid-August 1981 indicate that fishing success is considerably higher in 1981 than in the previous two years.

Approximately 50 U. S. jigboats fished in the central North Pacific during 1980. The area of operations extended from about 175°E and 160°W. Best catches during May-June were between about 32 to 35°N and as far north as about 40°N during July-August. Catches were landed in Honolulu, Hawaii, Dutch Harbor, Alaska and U. S. west coast ports. It is estimated that approximately 2700-3200 MT of albacore were caught. The size composition of the catch is given in NPALB/81/4.

C. Canadian Fishery

In 1980 the Canadian fishery lasted for less than one month because of late arrival of albacore and onset of poor fishing weather. About 130 trollers

(jig boats) participated in the fishery which was concentrated in a small area about 80 km off the Vancouver Island coast. Total catch was 165 MT compared with 521 MT in the previous year. Most of the fish were relatively large (13-15 kg).

At time of writing there was no information on fishing results in 1981. By late August there were few reports of albacore being present off the Canadian coast, and it is believed that Canadian vessels that entered the fishery moved southward off the coast of Washington and Oregon.

IV. CURRENT APPRAISAL OF THE STOCK

A. Catch Effort and C/E Trends

Catch Trends

Estimated annual catches of North Pacific albacore by country and gear type are shown in Table 1 for years 1952-1980 and Figure 1 for years 1961-1979.

Since the early 1960's, total catches of North Pacific albacore fluctuated annually, but showed a general increasing trend until 1976, when a peak catch of nearly 124,000 MT was recorded. During the early and middle 1970's, increased albacore catches reflected rapid development of the Japanese pole-and-line fishery. In 1977, the catch declined by 40% compared to the average of the preceding 6 years, again a reflection of sharply reduced Japanese pole-and-line catch. Catches in 1978 recovered to the 1974-77 average of 97,000 MT but in 1979 again the catch declined mainly because the North American catch fell to its lowest point in nearly 40 years.. little more than 7000 MT.

Effort Trends

Effort trends within each of the three major fisheries are shown in Table 2. Effective effort of Japanese longline fishery is the longest historical series available showing considerable variability but becoming relatively constant in the late 1970s at a level which corresponding to 0.75 of that in the 1960s and 1.4 times that of the early 1970s. Except for effort exerted in 1972, U. S. surface effort is rather stable, and close to the long-term (1961-78) average. Japanese pole-and-line effort experienced a conspicuous but irregular increase from the beginning of the 1970s. Recent average fishing effort was almost triple that of the 1960s. Revised fishing effort of the Japanese pole-and-line fishery, in terms of poles used, since 1972, is rather stable except for a high in 1978. It is relatively higher in the latest years. Table 3 shows the annual change in number of Japanese pole-and-line vessels by size. These statistics do not directly reflect the change in albacore fishing effort by pole-and-line vessels, because the fleet operates on skipjack even in the western equatorial Pacific. It was noted that the number of vessels larger than 100 gross tons, which account for more than 80% of the pole-and-line albacore catch, decreased remarkably in recent several years (NPALB/81/11).

Catch Rate Trends

CPUE of the Japanese pole-and-line fishery showed a slight decreasing trend from 1962 to 1980, with relatively higher values from 1970 to 1976. In 1974 a peak catch rate of approximately 8 MT/fishing day was reported (Table 4 and Figure 2). The catch rate reached a low of 3 MT/fishing day in 1977, followed by a slight increasing trend.

CPUE within the Japanese longline fishery (Table 4 and Figure 2) showed a steady decline from the early 1950s through 1960, increased substantially through 1966 and then declined through 1971. Since then the trend in catch rate has been stable. The recent CPUEs in pole-and-line fishery on young fish have declined and stabilized at 2/3 the level of the average in the early to middle 1960s when they were highest.

CPUE within the North American surface fishery showed no apparent upward or downward trend from 1961 through 1970 but declined from 1971 through 1980. CPUEs in 1979 and 1980 were the lowest observed since records began. The catch rates over the long term have been variable, being highest in the early 1970s when effort was also unusually variable.

B. Condition of the Stock

Two working papers on production model analysis for North Pacific albacore stock were presented (NPALB/81/13 and 16). NPALB/81/13 analyzed the catch, effort and CPUE data and updated those used in last year's production model (NPALB/80/16) for one more year, 1979. The results indicated that MSY estimates ranged from about 92,000 MT to 167,000 MT depending on choice of the production model's shape parameter, m . For all values of m the fit was approximately the same.

Another production model (NPALB/81/13) was based on newly estimated effort data on the Japanese pole-and-line fishery according to the standardization procedure of Honma (NPALB/80/5). The outputs from the model computation were similar to those of the above analysis. Estimated MSYs were 160,000, 96,000 and 97,000 MT for $m=0$, 1.00, and 2, respectively. All values of m fit about the same.

No other stock-model analyses, such as yield-per-recruit, stock-recruit relationship, etc., were presented at this workshop.

This discussion is based on current information as well as information from previous workshops. Assuming a unit North Pacific albacore stock production model analysis indicates MSY to be in the 95,000 MT to 170,000 MT range. This is based on data from existing fisheries and their current distribution. It should be realized that expansion of fisheries to previously unfished portions of the stock may increase MSY estimates. The objective choice of a single value for MSY is not possible because all production models fit the data approximately equally well. The 170,000 MT MSY estimate is about 40% greater than the maximum historical catch of 124,000 MT taken in 1976. These MSY estimates must be treated with caution. Further, growing evidence suggests that more than one stock of albacore may inhabit the North Pacific. In this case, a much different treatment of the data is indicated and separate evaluations for stocks should be done.

It must be noted, as done in previous workshops that the production model method demands many critical assumptions which may not be met. The index of North Pacific albacore abundance must accurately reflect the abundance of the stock and this may not be fully satisfied. Additionally, effort and catch histories used in the analyses span a short range of values which may affect the accuracy of the estimates. Thus, precision and reliability of the resulting MSY estimates remains uncertain.

The continued slow decline in CPUE of small fish in all fisheries warrants mention. Close monitoring of the stock appears to be needed. Again, as mentioned in 1979 and reported in 1980, greatly increased catches of small fish may eventually reduce the spawning stock which may in turn affect future recruitment.

V. RECOMMENDATIONS

The participants agreed to propose recommendations on several research subjects based on a result of discussions and research presented at this workshop. The following should be undertaken in the near future.

A. Improvement of Statistics

1. The coverage rate of U. S. west coast albacore data, noted to be dropping, should be measured and steps taken to improve the situation. Especially, catch and effort data from the mid-way area should be obtained.
2. Several U. S. released albacore were recovered recently by Korean longliners operating in the Northeastern Pacific. Statistics on the operation of Korean tuna boats should be investigated and historical data secured.
3. The new effective fishing effort, in terms of poles, for the Japanese pole-and-line fleet was presented at this workshop. These statistics should be expanded for the entire historical pole-and-line data series.
4. Albacore fishing by the Japanese drift gillnetting (OME-AMI) is a new and significant development in the North Pacific. The fleet's catch and effort data should be investigated and compiled.
5. Taiwanese albacore catch has been small in the North Pacific, which updated in Table 1. Further catch records should be obtained in the future.

B. Stock Structure

1. Bio-chemical methods for stock identifications should be examined further.
2. Efforts should be made to identify non-traditional means of identifying stock structure.
3. Simulation methods should be employed to examine the consistency of stock structure hypotheses and fishing data.

4. Oceanographic mechanisms which cause stock separation should be examined.
5. Evaluation of combined Japanese and United States tag data should be undertaken as soon as possible.

C. Biology

1. Calibration of "finray" and "daily increment" methods of age determination should be done and extended to develop an aging key.
2. Samples for age and growth should be stratified by area.
3. Physiology studies and further work with remote sensing tags are encouraged as a means of improving understanding of albacore behavior.

D. Stock Assessment

1. Production model analyses should be continued.
2. Yield-per-recruit analyses using revised age structures should be computed.
3. Simulation model analyses should be developed to test hypotheses critical to other analyses.

E. Ocean Environment

1. Oceanographic studies recommended at the Fifth North Pacific Albacore Workshop should be continued for input into simulation studies.
2. Application of remote sensing data to improve synoptic oceanography and for 1 (above) should be undertaken.

VI. ARRANGEMENTS FOR NEXT WORKSHOP AND ADJOURNMENT

It was agreed that the Seventh North Pacific Albacore Workshop that would be hosted by the SWFC, La Jolla, California, preferably during late spring 1982 in conjunction with the 33rd Annual Tuna Conference. Another meeting time suggested by FSFRL was during December 1982. Meeting dates and place, with other details, will be settled by correspondence between the SWFC and the FSFRL.

The draft report of the workshop was adopted by the participants. It will be finalized by mail and then published.

The chairman thanked the participants, for their cooperation and the meeting was adjourned.

Table 1. Catches for North Pacific albacore in metric tons, 1952-1980.

Year	Japan		Other Gear	Total	Taiwan		Pole-and-line		United States		Canada		Grand Total
	Pole-and-line	Longline			Longline				Jig	Sport	Jig		
1952	41,386	26,687	237	68,710					23,843	1,373		71	93,997
1953	32,921	27,777	132	60,830					15,740	171		5	76,746
1954	28,069	20,958	38	49,065					12,246	147		-	61,458
1955	24,236	16,277	136	40,649					13,264	577		-	54,490
1956	42,810	14,341	57	57,208					18,751	482		17	76,458
1957	49,500	21,053	151	70,704					21,165	304		8	92,181
1958	22,175	18,452	124	40,731					14,855	48		74	55,708
1959	14,252	15,502	67	30,121					20,990	-		212	51,323
1960	23,156	17,369	76	42,601					20,100	557		5	63,263
1961	18,636	17,437	268	36,341					12,054	1,355		4	52,591
1962	8,729	15,764	191	24,684					19,753	1,681		1	47,204
1963	26,420	13,464	218	40,102					25,142	1,161		5	68,512
1964	23,858	15,458	319	39,635					18,389	824		3	62,283
1965	41,491	13,701	121	55,313	26				16,461	731		15	72,953
1966	22,830	25,050	585	48,465	16				15,169	588		44	65,882
1967	30,481	28,869	520	59,870	17				17,814	707		161	82,682
1968	16,597	23,961	1,109	41,667	15				20,441	951		1,028	69,008
1969	32,107	18,006	1,480	51,593	21				18,826	358		1,365	75,157
1970	24,376	15,372	956	40,704	23				21,039	822		354	67,358
1971	53,198	11,035	1,262	65,495	24				22,496	1,175		1,587	92,548
1972	60,762	12,649	922	74,333	25				23,600	637		3,558	105,903
1973	69,811	16,059	1,922	87,792	35				15,652	72		1,270	107,057
1974	73,576	13,053	1,289	87,918	40				20,177	739		1,207	114,858
1975	52,157	10,060	568	62,785	28				18,926	1,243		101	86,326
1976	85,336	15,896	2,464	103,696	37				16,314	766		252	123,765
1977	31,934	15,737	1,727	49,398	561				10,012	619		53	62,140
1978	59,877	13,061	7,238	80,176	53				15,700	756		23	97,658
1979	44,562	14,249	4,136	63,049	81				-	-		521	70,281
1980	44,000	-	-	-	-				-	-		165	-

Remarks:

1. Catch data for years 1940-51 are referred to Table 1 of the report of preceding workshop, though incomplete.
2. Figures for 1980 are preliminary.
3. Japanese longline catch for 1952-60 excludes minor amount taken by vessels under 20 gross tons. Longline catch in weight is estimated by multiplying annual number of fish caught by an average weight statistics.
4. Japanese pole-and-line catch for years 1969-73 includes the catch by research vessels. After 1974, catch figures published by Statistics and Information Division include the catch by research vessels.
5. Taiwan longline catch is a total of high-sea and inshore fleets.
6. United States pole-and-line catch excludes minor amount taken by vessels not submitting log books to IATTC; this amount is included in the jig catch. Jig catch for years 1952-60 includes pole-and-line catch.
7. United States sport catch is estimated minimum based on partial coverage rate.
8. In the grand total, omitted are unknown but minor catches by longline and pole-and-line vessels of the Republic of Korea.

Table 2. Estimated effective effort by fishery for
North Pacific albacore in years 1961-1979

Year	Japan Longline (hooks x 10 ⁶)	Japan ¹ Pole-and-line (days)	(poles x 10 ³)	U.S. ¹ Effort (days)
1952	283.0			
1953	311.1			
1954	409.6			
1955	395.3			
1956	389.1			
1957	346.4			
1958	384.3			
1959	373.7			
1960	455.5			
1961	432.0	4,235		25,255
1962	309.0	1,209		27,464
1963	259.0	4,200		31,456
1964	232.4	3,478		30,355
1965	242.7	6,628		24,945
1966	276.8	3,843		25,756
1967	434.8	5,005		26,453
1968	355.8	3,108		29,175
1969	361.2	6,447		28,528
1970	253.2	3,958		20,165
1971	255.2	7,631		44,015
1972	186.7	9,695	227.8	67,319
1973	173.5	12,685	287.8	32,031
1974	153.8	9,421	226.4	39,748
1975	158.1	8,766	204.5	35,449
1976	227.2	13,921	278.9	38,445
1977	256.2	10,609	203.4	32,292
1978	252.8	16,725	321.9	32,111
1979	278.7	12,761	252.3	17,924

¹Japanese pole-and-line days are not the same as U.S. effort days.

Table 3. Number of Japanese pole-and-line vessels by size.

Year	Total Number	Size of Vessel (gross tons)				
		< 20	20-50	50-100	100-200	200>
1961	5523	5046	141	132	178	26
1962	4460	4009	186	111	126	28
1963	6533	6041	240	111	112	29
1964	4361	3829	291	103	106	32
1965	4226	3654	298	91	148	35
1966	4191	3620	299	71	167	34
1967	4114	3550	296	54	173	41
1968	3231	2670	276	60	170	55
1969	4008	3475	242	71	158(2)	56(3)
1970	3666	3148	220	91	143(3)	64(3)
1971	3684	3168	165	133	132(3)	86(3)
1972	4156	3596	131	162	119(3)	148(3)
1973	3587	2998	93	211(1)	83(3)	202(3)
1974	3941	3225	136	269	84	227
1975	3344	2648	95	283	39	279
1976	3754	3101	51	318	17	267
1977	4010	3348	40	348	14	260
1978	3680	3035	26	358	10	251
1979	4105	3480	14	370	13	228

() shows the number of prefectural research vessels included.

Table 4. Actual CPUE¹ statistics for major North Pacific
albacore fisheries, 1961-1980

Year	Fishing days	Japan Pole-and-line Poles	United States jig	Japan Longline		
				"Young" area(2)	"Main spawning" area(3)	Entire area(4)
1961	4.40		69.17	0.55	0.14	0.25
1962	7.22		124.59	0.67	0.14	0.30
1963	6.29		132.09	0.68	0.19	0.32
1964	6.86		97.61	0.90	0.19	0.40
1965	6.26		89.07	0.70	0.25	0.33
1966	5.94		90.45	1.20	0.27	0.54
1967	6.09		126.83	0.88	0.29	0.40
1968	5.34		135.23	0.84	0.29	0.38
1969	4.95		112.57	0.60	0.31	0.28
1970	6.13		127.39	0.66	0.27	0.31
1971	6.94		96.68	0.43	0.22	0.21
1972	6.25	266	61.08	0.63	0.30	0.30
1973	5.49	242	82.89	0.85	0.30	0.38
1974	7.81	325	105.17	0.64	0.30	0.34
1975	5.98	255	99.81	0.46	0.21	0.23
1976	6.13	306	69.22	0.66	0.21	0.30
1977	3.01	157	59.90	0.60	0.14	0.26
1978	3.58	186	86.80	0.52	0.17	0.23
1979	3.50	177	45.41	0.53	0.21	0.24
1980	4.44		36.78	-	-	-

¹Unit: MT/vessel-day and Kg/pole-day for Japan pole-and-line; fish/vessel-day for United States jig; fish/100 hooks for Japan longline.

(2) "Young" area is 25°-45°N from October to March and 30°-45°N from April to September.

(3) "Main spawning" area: 10°-25°N

(4) Entire area: 0°-45°N



Figure 1. Annual catches of North Pacific albacore of Japanese pole-and-line, Japanese longline and North American surface fisheries for years 1961-1979.

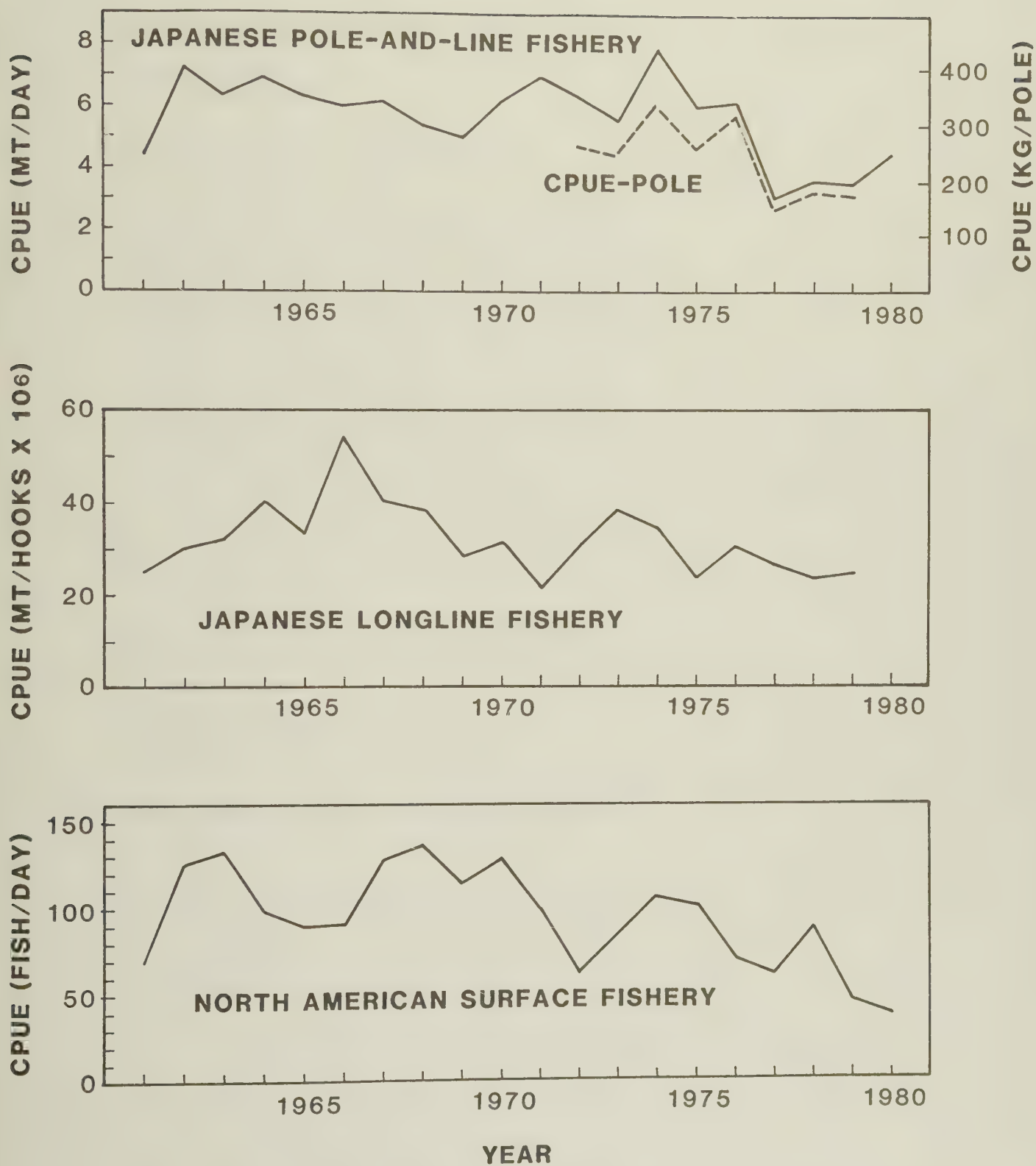


Figure 2. Annual catch rates of North Pacific albacore in the Japanese pole-and-line, Japanese longline and North American surface fisheries for years 1961-1980.

APPENDIX A

SIXTH NORTH PACIFIC ALBACORE WORKSHOP

LIST OF PARTICIPANTS

Southwest Fisheries Center, La Jolla

Norman Bartoo
R. Michael Laurs

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Kaoru Tatara (Director)
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Makoto Makihara
Kentaro Iwasa

APPENDIX B
SIXTH NORTH PACIFIC ALBACORE WORKSHOP
WORKING AGENDA

September 1 (Tuesday)

- | | |
|------------|--|
| 9:30 a.m. | 1. Meeting opening
2. Adoption of Agenda
3. Assignment of rapporteur's group
4. Review of presented working documents |
| 12:00 noon | - Lunch - |
| 1:30 p.m. | 5. Discussion on current research
1) Biology and ecology
2) Stock structure |
| 5:00 p.m. | - Adjourn for evening session - |

September 2 (Wednesday)

- | | |
|------------|--|
| 9:00 a.m. | 5. Discussion on current research (Continued)
3) Oceanographic aspects
4) Simulation modeling
5) Fisheries and stock dynamics |
| 12:00 noon | - Lunch - |
| 1:30 p.m. | 6. Review of current fisheries |
| 5:00 p.m. | - Adjourn - |

September 3 (Thursday)

- | | |
|------------|--|
| 9:00 a.m. | 7. Current appraisal of stock status
1) Catch, effort and catch rate trends
2) Population parameters and stock analysis
3) Condition of the stock |
| 12:00 noon | - Lunch - |
| 1:30 p.m. | 8. Recommendations
1) Statistics
2) Fishery biology
3) Fishery oceanography
4) Stock assessment |
| 5:00 p.m. | - Drafting time for each rapporteur's group -
- Adjourn - |

September 4 (Friday)

- | | |
|-----------|--|
| 9:00 a.m. | 9. Drafting and adoption of the report
10. Arrangement for next workshop
11. Adjournment |
|-----------|--|

APPENDIX C

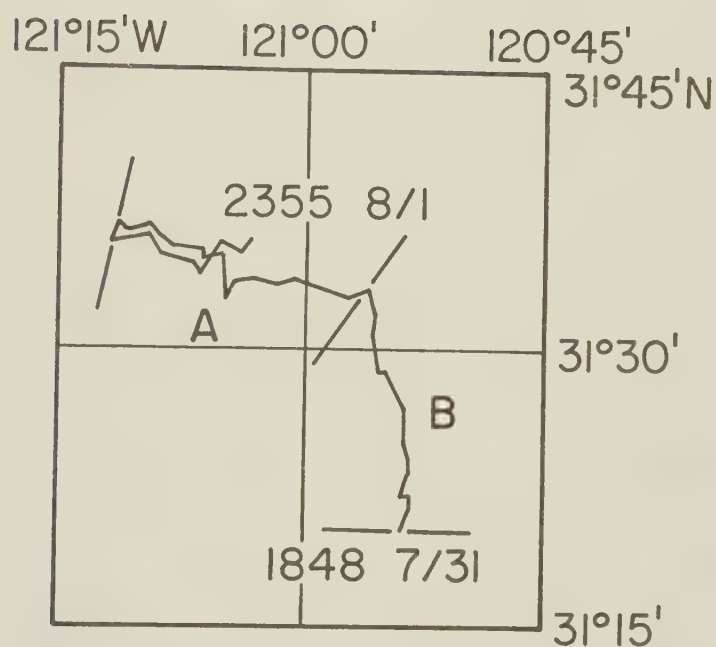
SIXTH NORTH PACIFIC ALBACORE WORKSHOP

LIST OF WORKING PAPERS

<u>Ref. No.</u>	<u>Author</u>	<u>Title</u>
NPALB/81/1	E. Weber N. Bartoo	The North American Fishery for Albacore (<u>Thunnus alalunga</u>) in the North Pacific.
2	N. Bartoo K. Parker	Stochastic Age-Frequency Estimation Using the Von Bertalanfy Growth Equation.
3	N. Bartoo L. Bledsoe	North Pacific Albacore Modeling Progress Report through August 1981.
4	R. M. Laurs N. Bartoo	Review of the 1980 U. S. North Pacific Albacore Fishery.
5	J. Graves R. M. Laurs	An Electrophoretic Investigation of Protin Variability in the North Pacific Albacore.
6	R. M. Laurs R. Nishimoto	Evaluation of the Otolith Daily Ring Increment Method for Age Determination in North Pacific Albacore.
7	K. Ketchen	Further Studies on the Age and Growth of North Pacific Albacore Using Finray Cross-Sections.
7a	K. Ketchen	Photographs of Albacore Dorsal Finray Cross-Sections (Limited distribution)
8	M. Asano	Results of Albacore Tagging in the North Pacific (Preliminary). (Tables and Figures)
9	A. Naganuma	Analysis on the Catch in Number by Age of Albacore Caught by Pole-and-line Fishery in the Northwestern Pacific (Preliminary). (Tables and Figures)
10	J. Morita I. Yamanaka	Surface Temperature Pattern Obtained by Infra-Red Image of the Geostational Satellite (GMS-1) in Relation to the Pole-and-line Fishing Ground in the North Pacific.
11	T. Shiohama	Review of the Current Japanese North Pacific Albacore Fisheries, 1981.
12	T. Shiohama	Distribution of the North Pacific Albacore As Seen From the Longline Size Compositions by Area.

- | | | |
|-------------|----------------------------|---|
| NPALB/81/13 | S. Kume | Estimation of Effective Fishing Effort of Japanese Pole-and-line Fishery for Albacore in the North Pacific Ocean. |
| 14 | T. Yonemori
M. Honma | Large Mesh Drift Gillnet (OME-AMI) Fishery in the North Pacific. |
| 15 | Anonymous | Annual Report of Tuna Tagging Program, 1980. (In Japanese: Results of tagging program by Far Seas Fisheries Research Laboratory). |
| 16 | T. Shiohama | A Brief Stock Assessment of North Pacific Albacore by Generalized Production Model, 1961-1979. |
| 17 | T. Yonemori
M. Makiyara | Distribution of Albacore in the North Pacific as Indicated by An Experimental Gillnetting. |
| 18 | S. Kume
N. Bartoo | Report of the Fifth North Pacific Albacore Workshop. (La Jolla, the United States, June 30-July 3, 1980). (English and Japanese versions) |

APPENDIX D
VERTICAL DISTRIBUTION AND OCEAN TEMPERATURE RELATIONSHIPS
FOR ALBACORE BASED ON ACOUSTIC TRACKING EXPERIMENT.



FISH TRACK

Figure D-1. Track followed by an acoustic-tagged albacore for a 30-hour period.

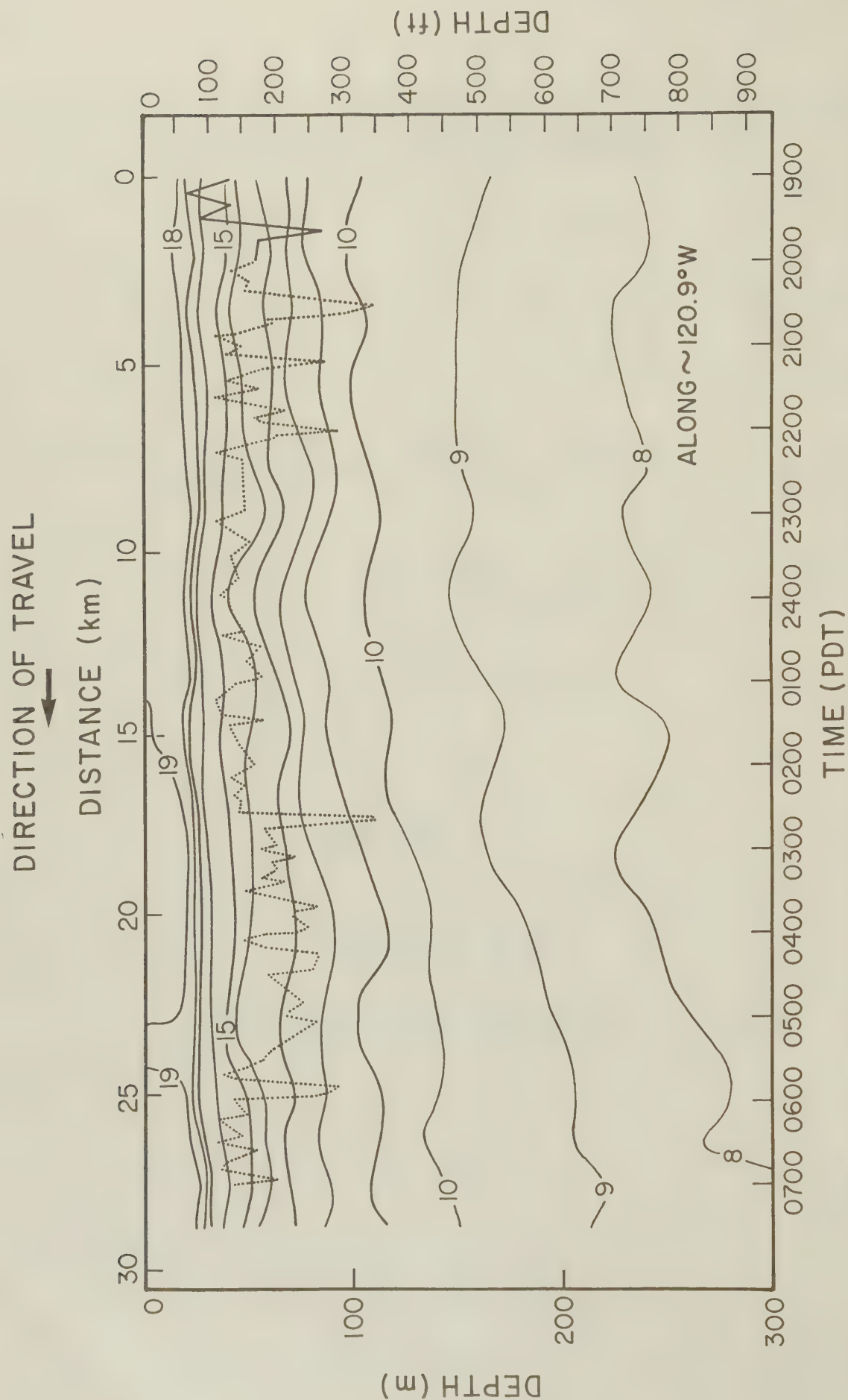


Figure D-2. Swimming depth of albacore measured by acoustic telemetry and vertical temperature structure for portion B of track shown in Figure D-1. Solid line indicates daytime hours and dotted line night time hours.

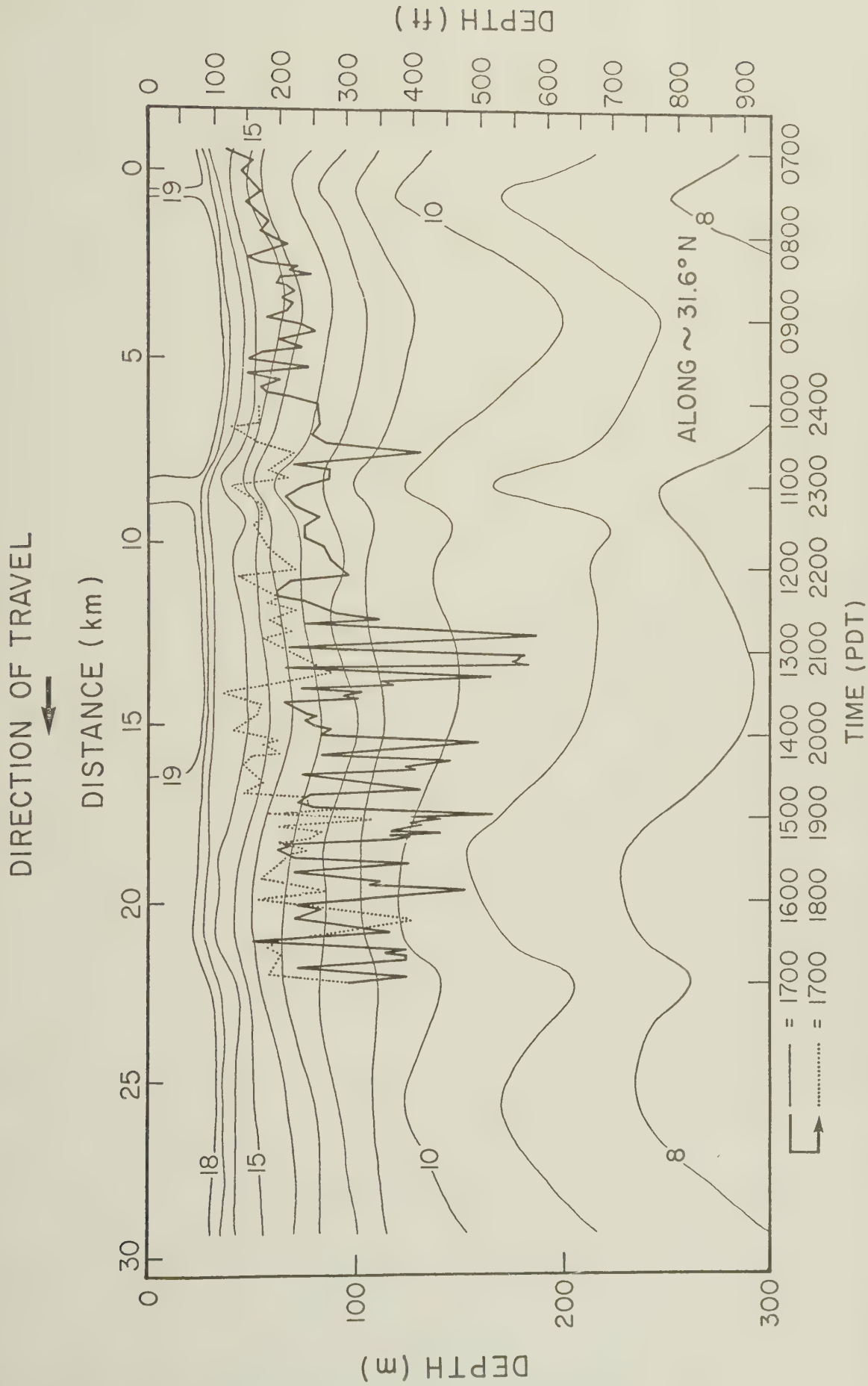


Figure D-3. Swimming depth of albacore measured by acoustic telemetry and vertical temperature structure for pattern A of track shown in Figure D-1. Solid line indicates daytime hours and dotted line night time hours.

